Electrical and Computer Engineering (ECE)

Courses

ECE 115. Introduction to Electrical and Computer Engineering. 4 hours.
Concepts of electrical and computer engineering including: ciruit analysis, fundamental electromagnetics, electronic devices, sensors, communication, digital logic, programming, numerous practical applicaitons; laboratory. Course Information: Much MATLAB programming, which is taught in the course, is required. Prerequisite(s): Credit or concurrent registration in MATH 180; or Grade of C or better in MATH 165. *Natural World - With Lab course.*

ECE 194. Special Topics in Electrical and Computer Engineering. 1-4 hours.
Multidisciplinary electrical and computer engineering topics at first-year level that vary from term to term depending on current student and instructor interests. Course Information: May be repeated.

ECE 210. Electrical Circuit Analysis. 3 hours.
Linear circuit analysis: networks, network theorems, dependent sources, operational amplifiers, energy storage elements, transient analysis, sinusoidal analysis, frequency response, filters. Laboratory. Course Information: Prerequisite(s): Credit or concurrent registration in MATH 180. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 225. Circuit Analysis. 4 hours.
Electric circuit elements; Ohm's Law; Kirchhoff's laws; transient and steady-state analysis of circuits; Laplace transform methods; network theorems. Laboratory. Course Information: Credit is not given for ECE 225 if the student has credit for ECE 210. Prerequisite(s): Credit or concurrent registration in MATH 220; and a Grade of C or better in PHYS 142; and Grade of C or better in ECE 115. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ECE 265. Introduction to Logic Design. 4 hours.
Number Systems; Binary arithmetic; Boolean/Logic functions; Boolean Algebra; logic gates, their CMOS design; function minimization, analysis and synthesis of combinational and sequential circuits. Course Information: Credit is not given for ECE 265 if the student has credit for CS 266 or CS 366. Laboratory. Prerequisite(s): MATH 180 and grade of C or better in ECE 115. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 266. Introduction to Embedded Systems. 4 hours.
Introduction to embedded systems and microcontroller; instruction set; data representations; assembly programming; mixed C/assembly programming; memory organization; interrupt processing; I/O devices and interfacing; programming laboratory. Course Information: Credit is not given for ECE 266 if the student has credit in CS 261. Extensive computer use required. Prerequisite(s): CS 107; and Credit or concurrent registration in ECE 265. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Laboratory.

ECE 267. Computer Organization I. 3 hours.
Introduction to computer organization and assembly language programming. Memory, CPU, and I/O organization. Programming techniques and tools. Course Information: Credit is not given for ECE 267 if the student has credit for CS 266 or CS 366. Prerequisite(s): CS 107; and credit or concurrent registration in ECE 265.

ECE 294. Special Topics in Electrical and Computer Engineering. 1-4 hours.
Multidisciplinary electrical and computer engineering topics at second-year level that vary from term to term depending on current student and instructor interests. Course information: May be repeated if topics vary.

ECE 310. Discrete and Continuous Signals and Systems. 3 hours.
Signals; systems; convolution; discrete and continuous Fourier series and transforms; Z-transforms; Laplace transforms; sampling; frequency response; applications; computer simulations. Course Information: Prerequisite(s): MATH 220 and credit or concurrent registration in ECE 225; or credit or concurrent registration in ECE 210 for non-ECE students.

ECE 311. Communication Engineering. 4 hours.
Continuous-time signals and spectra; amplitude and angle modulation, sampling and quantization theory; digital pulse modulation, error probability, commercial broadcasting practices. Course Information: Prerequisite(s): Grade of C or better in ECE 310; and Credit or concurrent registration in ECE 341. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ECE 317. Digital Signal Processing I. 4 hours.
Sampling theorem; discrete signals and systems; discrete time Fourier transform; DFT; FFT; IIR and FIR digital filter design; stability; DSP applications. Laboratory. Course Information: Prerequisite(s): Grade of C or better in ECE 310. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ECE 322. Introduction to Electromagnetics and Applications. 4 hours.
Transmission lines. Plane waves in various media. Polarization and Stoke's parameters. Scalar and vector potentials. Guided wave propagation. Radiation. Linear antennas and antenna parameters. Course Information: Prerequisite(s): ECE 225. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

ECE 333. Computer Communication Networks I. 4 hours.
A balanced presentation focuses on the internet as a specific motivating example of a network and also introduces internet protocols in a more theoretical context. Course Information: Credit is not given for ECE 333 if the student has credit for CS 450. Prerequisite(s): ECE 341 and CS 107. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ECE 340. Electronics I. 4 hours.
Operational amplifiers. Semiconductor junctions. Bipolar and field-effect transistors. Simple transistor amplifier and switching applications. Introduction to digital logic circuits. Laboratory experience. Course Information: Prerequisite(s): Grade of C or better in ECE 225. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 341. Probability and Random Processes for Engineers. 3 hours.
Probability, random variables, discrete and continuous distributions, transformation of random variables, expectation, generating functions, statistical inference, hypothesis testing, estimation, random processes, stationarity, applications. Course Information: Credit is not given for ECE 341 if the student has credit for IE 342. Prerequisite(s): Grade of C or better in MATH 210.

ECE 342. Electronics II. 4 hours.
Differential amplifiers. Feedback amplifiers. Frequency response, stability and compensation of amplifiers. Circuit implementation of logic gates in various logic families. Bistable and memory circuits. Laboratory. Course Information: Prerequisite(s): ECE 340. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 346. Solid State Device Theory. 4 hours.
Introduction to semiconductors, Energy bands, Electron and hole transport mechanisms in semiconductor devices, recombination and generation, P-N Junctions. Intro to metal-oxide-semiconductor field effect transistors. Practical laboratory. Course Information: Prerequisite(s): MATH 220 and a grade of C or better in ECE 115 and a grade of C or better in PHYS 142. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ECE 347. Integrated Circuit Engineering. 3 hours.
Students learn to make real semiconductor devices, what are the most common techniques for integrated circuits fabrication, and what are the limitations. Students learn concepts of diffusion, oxidation, implantation, lithography, etching, and deposition. Course Information: Prerequisite(s): CHEM 122; and Grade of C or better in ECE 225.

ECE 350. Principles of Automatic Control. 4 hours.
Transfer function; block diagrams; flow graphs; state space canonic forms; stability analysis; steady state and transient analysis; feedback control; continuous to discrete conversion; digital control. Course Information: Prerequisite(s): MATH 310 and grade of C or better in ECE 310. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ECE 366. Computer Organization. 3 hours.
Software/hardware interaction in a computer. Compiler, assembler and linker, machine code. Clocking, datapath, control unit, ALU and memory design, cache memory, pipelining. Course Information: Credit is not given for ECE 366 if the student has credit for CS 261 or CS 262. Prerequisite(s): ECE 266.

ECE 367. Microprocessor-Based Design. 4 hours.
Microprocessor architecture; microprogrammed machines; programmer's model; control signals and timing; system buses; parallel and serial interfacing; interrupt processing; I/O devices; memory devices; direct memory access; assembly language. Laboratory. Course Information: Prerequisite(s): ECE 267; and a grade of C or better in ECE 265 or a grade of C or better in CS 366. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 368. CAD-Based Digital Design. 4 hours.
Semi-complex circuit and system design techniques, data path control using FSMs, VHDL programming, circuit/system design projects using VHDL and CAD tools (VHDL Simulation, Circuit Synthesis). Course Information: Credit is not given for ECE 368 if the student has credit for CS 469. Laboratory. Prerequisite(s): ECE 366. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

ECE 391. Electrical and Computer Engineering Practicum. 1 hour.
Provides students with the opportunity to apply the skills and knowledge gained in previous engineering courses within a professional, working environment. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 1 hour awarded toward degree requirements. Prerequisite(s): Approval of the Department.

ECE 392. Undergraduate Research. 1-5 hours.
Research under close supervision of a faculty member. Course Information: Satisfactory/Unsatisfactory grading only. Prerequisite(s): Consent of the instructor.

ECE 394. Special Topics in Electrical and Computer Engineering. 1-4 hours.
Multidisciplinary electrical and computer engineering topics at third-year level that vary from term to term depending on current student and instructor interests. Course Information: May be repeated if topics vary.

ECE 396. Senior Design I. 2 hours.
Introduction to the principles and practice of product design: specifications, evaluation of design alternatives, technical reports, and oral presentations. Independent design projects. Course Information: Prerequisite(s): ENGL 161; and ECE 225; and ECE 340 or ECE 346 or ECE 366. Open only to seniors.

ECE 397. Senior Design II. 2 hours.
Implement and test the group project designed in ECE 396; professional development; group presentations including participation at EXPO. Course Information: Prerequisite(s): ECE 396. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Laboratory.

ECE 407. Pattern Recognition I. 3 or 4 hours.
The design of automated systems for detection, recognition, classification and diagnosis. Parametric and nonparametric decision-making techniques. Applications in computerized medical and industrial image and waveform analysis. Course Information: Same as BME 407. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 341 or BME 339 or IE 342 or STAT 381.

ECE 410. Advanced Circuit Analysis. 3 or 4 hours.
Matrix algebra for network analysis, network parameters, macromodeling, high-frequency measurements, network functions and theorems. Topics in computer-aided analysis. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): MATH 310 and grade of C or better in ECE 310.

ECE 412. Introduction to Filter Synthesis. 3 or 4 hours.
Fundamentals of network synthesis, filter approximations and frequency transformations. Active filter synthesis using bi-linear and bi-quad circuits. Topics in computer-aided design. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in ECE 310.

ECE 415. Image Analysis and Computer Vision I. 3 or 4 hours.
Image formation, geometry and stereo. Two-dimensional image analysis by fourier and other 2-D transforms. Image enhancement, color, image segmentation, compression, feature extraction, object recognition. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in ECE 310.

ECE 417. Digital Signal Processing II. 0-5 hours.
Computer-aided design of digital filters; FFT algorithms and applications; multirate signal processing and wavelets; random signals and Wiener filtering; basics of 2-D DSP.Course Information: 4 undergraduate hours. 5 graduate hours. Prerequisite(s): ECE 317. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ECE 418. Statistical Digital Signal Processing. 3 or 4 hours.
Stochastic signal models, LMS identification, identification of signals from noise, Wiener filtering, blind separation of mixed signal, discrete Wavelet Transforms, compression and denoising, ceptral analysis. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 317 and ECE 341.

ECE 421. Introduction to Antennas and Wireless Propagation. 3 or 4 hours.
Potential, antenna parameters, radiation from linear wires and loops, impedance, arrays, communication links and path loss, tropospheric propagation, fading and diversity. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 225 and ECE 322.

ECE 423. Electromagnetic Compatibility. 0-5 hours.
EMC requirements for electronic systems. Nonideal behavior of components. Radiated and conducted emissions. Susceptibility. Coupling and shielding. Electrostatic discharge. System design for EMS. Course Information: Prerequisite(s): MATH 310 and ECE 322. To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

ECE 424. RF and Microwave Engineering. 0-5 hours.
Transmission lines, Smith chart, strip, active RF devices and components, power amplifiers, voltage-controlled oscillators, mixers, wireless communication and radar systems, resonators, two-port parameters, power and energy considerations. Course Information: 4 undergraduate hours. 5 graduate hours. Prerequisite(s): ECE 225 and ECE 322. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ECE 432. Digital Communications. 3 or 4 hours.
Source coding, quantization, signal representation, channel noise, optimum signal reception, digital modulation: ASK, PSK, FSK, MSK, M-ary modulation. Probability of error. Inter-symbol interference. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): MATH 310, ECE 311 and ECE 341.

ECE 434. Multimedia Systems. 3 or 4 hours.
Multimedia systems; compression standards; asynchronous transfer mode; Internet; wireless networks; television; videoconferencing; telephony; applications. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): ECE 310.

ECE 436. Computer Communication Networks II. 3 or 4 hours.
Explores integrated network architecture of service, control signaling and management, examples of high-speed LAN/WAN, next generation Internet and mobile wireless network. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): ECE 333.

ECE 437. Wireless Communications. 3 or 4 hours.
Cellular concept, frequency reuse, mobile radio propagation, channel fading, noise in analog communications, mobile radio channel equalization, multiple access techniques (FDMA, TDMA, CDMA), wireless networking. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 311 and ECE 341.

ECE 440. Nanoelectronics. 3 or 4 hours.
Wave-particle duality, Schrodinger equation, atomic orbitals, band theory of solids. Semiconductor and carbon nanoelectronic materials. Nanostructure device fabrication. Nanoelectromechanical systems. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 346; or consent of the instructor.

ECE 442. Power Semiconductor Devices and Integrated Circuits. 0-5 hours.
Encompasses fundamentals of primarily silicon based power semiconductors with regard to basic physical principles, breakdown mechanisms, high voltage bipolar and insulated gate devices, and basic packaging issues.Course Information: 4 undergraduate hours. 5 graduate hours. Credit is not given for ECE 442 if the student has credit for EECS 442. ECE 442 is a supplement for ECE 445 and ECE 545. Prerequisite(s): ECE 346. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 445. Analysis and Design of Power Electronic Circuits. 0-5 hours.
Analysis of different isolated and non-isolated power-converter topologies, understanding of power-converter components, switching schemes. Course Information: 4 undergraduate hours. 5 graduate hours. Prerequisite(s): ECE 342. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 448. Transistors. 3 or 4 hours.
Bipolar junction transistors, electronic processes in surface-controlled semiconductor and dielectric devices. Metal oxide semiconductor filed effect transistors, surface and interface effects, diode lasers, integrated optoelectronic devices. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 346.

ECE 449. Microdevices and Micromachining Technology. 0-5 hours.
Microfabrication techniques for microsensors, microstructures, and microdevices. Selected examples of physical/chemical sensors and actuators. Simulation experiments. Course Information: Same as ME 449. 4 undergraduate hours. 5 graduate hours. Laboratory. Prerequisite(s): ECE 347; or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ECE 451. Control Engineering. 3 or 4 hours.
Continuous-and discrete-time state-space models; solutions to state equations; stability; reachabilty/controllability, state feedback, tracking; observability, observers, output feedback; optimal control and estimation. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 350; and Grade of C or better in MATH 310.

ECE 452. Robotics: Algorithms and Control. 3 or 4 hours.
Kinematic and dynamic modeling of robots; configuration space; motion planning algorithms; control of robots; sensors and perception; reasoning; mobile robots. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in ECE 310; and MATH 310.

ECE 454. Mechatronic Embedded Systems Design. 0-5 hours.
Design and fabrication of scaled-down autonomous vehicles, from an embed system perspective; mechatronic components such as motors, microcontrollers, power supply, sensors, control algorithms, project oriented, culminating in racing competition. Course Information: 4 undergraduate hours. 5 graduate hours. Prerequisite(s): ECE 266 and ECE 310 and ECE 340; or consent of the instructor. Recommended Background: ECE 350 and ECE 412 and ECE 451. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

ECE 458. Electromechanical Energy Conversion. 0-4 hours.
Electromagnetic forces and torque; magnetic circuits and transformers; DC machines; three-phase AC synchronous and induction machines; laboratory-demonstrations. Projects are required. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in ECE 225. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 464. Testing and Reliability of Digital Systems. 3 or 4 hours.
Theory, practice and recent innovations in the testing and reliability of modern digital systems. Topics: fault modeling / simulation, automatic test pattern generation, built-in self-test, fault tolerance. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): CS 251; and ECE 366.

ECE 465. Digital Systems Design. 3 or 4 hours.
Switching algebra, combinational circuits, Mux, ROM, DCD, PLA-based designs, advanced combinational circuit minimization techniques, sychronous and asynchronous sequential circuit synthesis (minimization, hazards, races, state assignment) testing. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade C or better in PHYS 142; and ECE 366.

ECE 466. Computer Architecture. 3 or 4 hours.
Design principles of computer architecture. Topics include: instruction set architecture, pipelining, instruction-level parallelism, caches, main memory, and thread-level parallelism. Course Information: Same as CS 466. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 366 or CS 261.

ECE 467. Introduction to VLSI Design. 0-5 hours.
MOS, CMOS circuits VLSI technology, CMOS circuit characterization and evaluation. Static and dynamic MOS circuits, system design, faults, testing, and symbolic layout. Laboratory. Course Information: 4 undergraduate hours. 5 graduate hours. Prerequisite(s): ECE 340. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 468. Analog and Mixed - Signal Integrated Circuits. 0-5 hours.
Review of basic analog concepts; Sampling and mixed-signal interface circuits; analytical analysis and CAD-based design/simulation; emphasis on compact modeling, design tradeoffs, and intuitive design approaches. Course Information: 4 undergraduate hours. 5 graduate hours. Prerequisite(s): ECE 342.Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

ECE 469. Hardware Description Language Based Digital and Computer System Design. 0-5 hours.
Hardware description language (HDL) introduction; digital system design including arithmetic circuit, datapath and control; basic processor architecture and design; use of CAD tools for simulation, synthesis, and verification. Course Information: 4 undergraduate hours. 5 graduate hours. Prerequisite(s): ECE 366; and ECE 465. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Laboratory.

ECE 491. Seminar. 1-4 hours.
Topics of mutual interest to a faculty member and a group of students. Offered as announced by department bulletin or the Timetable. Course Information: May be repeated. Prerequisite(s): Consent of the instructor.

ECE 493. Special Problems. 1-5 hours.
Special problems or reading by special arrangement with the faculty. Course Information: No graduation credit for students in the following: MS in Electrical and Computer Engineering or PhD in Electrical and Computer Engineering. Prerequisite(s): Consent of the instructor.

ECE 496. Undergraduate Senior Design Thesis I. 0-8 hours.
Introduction to engineering design and research methods: design tools, product conception and development, simulation, prototyping, technical reports and presentations, literature survey and undergraduate thesis. Course Information: Credit for ECE 496 only given to non-degree students. No graduation credit is given for ECE 496 to students enrolled in any degree program in Engineering. Extensive computer use required. Prerequisite(s): Consent of the instructor.

ECE 497. Undergraduate Senior Design Thesis II. 0-8 hours.
Introduction to engineering design and research methods: design tools, product conception and development, simulation, prototyping, technical reports and presentations, literature survey and undergraduate thesis. Course Information: Credit only given to non-degree students. No graduation credit given to students enrolled in Engineering. Extensive computer use required. Prerequisite(s): Consent of the instructor.

ECE 499. Professional Development Seminar. 0 hours.
Graduating seniors will be provided with information regarding future career paths and will provide information regarding the program to be used for assessment purposes. Course Information: Satisfactory/Unsatisfactory grading only. Prerequisite(s): Open only to seniors; and approval of the department. Must be taken in the student's last semester of study.

ECE 508. Convex Optimization. 4 hours.
Convex sets, functions, and optimization problems; duality theory; optimization algorithms: gradient method, Newton's method, interior-point methods; applications to machine learning, and signal processing. Course Information: Prerequisite(s): MATH 310; and ECE 341; or consent of the instructor.

ECE 510. Advanced Network Analysis. 4 hours.
Characterizations of networks. The indefinite-admittance matrix. Active two-port networks. Theory of feedback amplifiers. Stability of feedback amplifiers. Multiple-loop feedback amplifiers. Course Information: Prerequisite(s): ECE 410.

ECE 515. Image Analysis and Computer Vision II. 4 hours.
Image analysis techniques, 2D and 3D shape representation, segmentation, camera and stereo modeling, motion, generic object and face recognition, parallel and neural architectures for image and visual processing. Course Information: Prerequisite(s): ECE 415; or consent of the instructor.

ECE 516. Adaptive Digital Filters. 4 hours.
Properties of signals; optimal filters, Wiener and Kalman filters; signal modeling, adaptive filters channel equalizing, echo canceling, noise canceling, and linear prediction; filter properties. Course Information: Prerequisite(s): ECE 317 and ECE 341; and MATH 310 or MATH 320.

ECE 517. Digital Image Processing. 4 hours.
Operations on 2-D digital images: transforms, enhancement, restoration, warping, segmentation, registration, compression, water marking, steganography, and reconstruction from projection. Course Information: Prerequisite(s): ECE 317 and ECE 341.

ECE 520. Electromagnetic Field Theory. 4 hours.
Maxwell's equations. Potentials. Constitutive relations. Special relativity. Boundary conditions. Green's functions. Polarization. Radiation from antennas and charged particles. Waveguides and resonators. Exterior boundary - value problems. Course Information: Prerequisite(s): ECE 421.

ECE 521. Computational Electromagnetics. 4 hours.
Finite-element, finite-difference solution. Computer aided solutions: integral equations, method of moments, transform and iterative solutions. FD-TD, singularity expansion method. Practical problems in radiation and scattering. Course Information: Prerequisite(s): ECE 520.

ECE 522. Advanced Microwave Theory. 4 hours.
Microwave integrated circuits: analysis, design. Microwave devices: filters, cavities and phase shifters. Millimeter waves: components and circuits, millimeter wave applications. Course Information: Prerequisite(s): ECE 420 and ECE 520.

ECE 523. Advanced Antenna Engineering. 4 hours.
Radiation from helix and spiral; aperture antennas; linear and planar array synthesis; Hallen's and other methods for impedance; design of array feeds; reflector and lens antennas. Course Information: Prerequisite(s): ECE 421 and ECE 520.

ECE 526. Electromagnetic Scattering. 4 hours.
Exact solutions of exterior boundary-value problems. Low-frequency expansions. High-frequency methods, including geometrical and physical theories of diffraction. Hybrid techniques. Radar cross-sections. Course Information: Prerequisite(s): ECE 520.

ECE 530. Random Signal Analysis. 4 hours.
Probability for communications, properties and series representations of random processes, random processes through linear and non-linear systems, minimum MSE and maximum SNR systems. Course Information: Prerequisite(s): ECE 341 or consent of the instructor.

ECE 531. Detection and Estimation Theory. 4 hours.
Bayes, Neyman-Pearson and minimax detection for discrete and continuous time random processes. Estimation of random and non-random signal parameters. Estimation of signals. Course Information: Prerequisite(s): ECE 418 or consent of the instructor.

ECE 532. Advanced Digital Communications. 4 hours.
Characteristics of digitally modulated signals; digital signals in additive noise; communication over fading channels and with intersymbol interference; source and channel coding; synchronization; spread spectrum techniques. Course Information: Prerequisite(s): ECE 432 or consent of the instructor.

ECE 533. Advanced Computer Communication Networks. 4 hours.
Computer and telecommunication networks; integrated (data, voice, and video) services; network performance; Quality of Service provisioning. Course Information: Prerequisite(s): ECE 333 and ECE 341; or consent of the instructor.

ECE 534. Elements of Information Theory. 4 hours.
Entropy and mutual information, fundamentals of coding theory, data compression, complexity of sources, channel mutual information and capacity, rate distortion theory, information theory applications. Course Information: Prerequisite(s): ECE 341 or consent of the instructor.

ECE 540. Physics of Semiconductor Devices. 4 hours.
Electrons in periodic lattice; equilibrium carrier distribution; energy band diagrams in junctions, in homogeneous semiconductors; recombination and generation; non-equilibrium processes, radiation and electric fields; diodes. Course Information: Same as PHYS 540. Prerequisite(s): ECE 346 or the equivalent.

ECE 541. Microelectronic Fabrication Techniques. 4 hours.
Current fabrication techniques of microelectronic technology; plasma and CVD processes; etching techniques; ion implantation; surface analytical methods. Course Information: Same as ME 541. Prerequisite(s): ECE 347 or ECE 449.

ECE 542. Advanced Semiconductor Devices. 4 hours.
Bipolar Transistor and Related Devices, MOSFET Transistor and Related Devices, MESFET and Related Devices, Quantum-Effect Devices, Photonic Devices. Course Information: Prerequisite(s): ECE 540.

ECE 545. Advanced Power-Electronics Design. 4 hours.
High-frequency-magnetics design and measurement, parasitics, modeling, estimation, and measurement, soft switching for DC-DC converters, distributed DC-DC converters, and design layout. Course Information: Prerequisite(s): ECE 445.

ECE 550. Linear Systems Theory and Design. 4 hours.
State variable description, linear operators, impulse response matrix, controllability, observability, reducible and irreducible realizations, state feedback, state observers and stability. Course Information: Prerequisite(s): ECE 350.

ECE 551. Optimal Control. 4 hours.
Optimal control of dynamic systems in continuous and discrete time, maximum principle, dynamic programming and constraints, learning systems. Course Information: Prerequisite(s): ECE 550 or consent of the instructor.

ECE 552. Nonlinear Control. 4 hours.
Nonlinear phenomena, linear and piecewise linear approximations, describing functions, servomechanisms, phase plane, limit cycles, Lyapunov's stability theory, bifurcation, bilinear control, vibrational control, learning systems. Course Information: Prerequisite(s): ECE 550 or consent of the instructor.

ECE 559. Neural Networks. 4 hours.
Mathematical neuron models, learning methods, the perceptron, basic nonlinear optimization, backpropagation algorithm, associative memory, hopfield networks, SVM, vector quantization, SOM, PCA, convolutional networks, deep learning. Course Information: Same as CS 559. Prerequisite(s): Consent of the instructor. - Knowledge of calculus, linear algebra, and the ability to write computer programs are assumed.

ECE 564. Hardware Security and Trust. 4 hours.
Hardware security based on physical disorder; hardware metering and watermarking; trusted embedded system design; countermeasures against invasive and non-invasive attacks; hardware trojan detection and prevention. Prerequisite(s): ECE 465; or consent of the instructor. Recommended background: An understanding of digital system design.

ECE 565. Physical Design Automation. 4 hours.
Computer-aided physical design of integrated circuits; circuit partitioning and placement; floorplanning; global and detailed routing; timing optimization; general optimization tools: local search, constraint relaxation. Course Information: Same as CS 565. Prerequisite(s): CS 401; and CS 466 or ECE 465.

ECE 566. Parallel Processing. 4 hours.
Parallel processing from the computer science perspective. Includes Architecture (bus based, lockstep, SIMD), Programming Languages (Functional, traditional and extensions), compilers, interconnection networks, and algorithms. Course Information: Same as CS 566. Prerequisite(s): CS 466 or ECE 466; and CS 401.

ECE 567. Advanced VLSI Design. 4 hours.
VLSI subsystem and system design: synthesis, design styles, design process, testing. Case Studies: switching networks, graphics engine, CPU. Projects use computer-aided design tools. Course Information: Prerequisite(s): ECE 467.

ECE 568. Advanced Microprocessor Architecture and Design. 4 hours.
Microprocessors; embedded control; processor core; system-on-chip; power-aware design; SMT design; Java processors; media processors; network processors; crypto processors; trusted processor architectures; architecture simulation. Course Information: Extensive computer use required. Prerequisite(s): ECE 466 and consent of the instructor.

ECE 569. High-Performance Processors and Systems. 4 hours.
Instruction-level parallelism, multiple-instruction issue, branch prediction, instruction and data prefetching, novel cache and DRAM organization, high-performance interconnect, compilation issues, case studies. Course Information: Same as CS 569. Prerequisite(s): CS 466 or ECE 466; and graduate standing.

ECE 572. Nanoscale Semiconductor Structures: Electronic and Optical Properties. 4 hours.
Electronic and optical properties of nanscale semiconductors and devices, carrier interactions in dimensionally-confined nanostructures, deformation potential, piezoelectric potential, polar-optical-phonon interaction potential. Course Information: Prerequisite(s): PHYS 244 & ECE 346. Recommended background: Background in semiconductor device fundamentals such as covered in ECE 346 as well as the underlying physical principles as covered in PHYS 244.

ECE 591. Electric al and Computer Engineering Internship. 1 hour.
Provides students with the opportunity to apply the skills and knowledge gained in previous engineering courses within a professional, working environment. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 2 hours awarded toward degree requirements. Prerequisite(s): Approval of the Department.

ECE 594. Special Topics. 4 hours.
Subject matter varies from term to term and section to section, depending on the specialities of the instructor. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Consent of the instructor.

ECE 595. Departmental Seminar. 0 hours.
Seminar by faculty and invited speakers. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated.

ECE 596. Individual Study. 1-4 hours.
Individual study or research under close supervision of a faculty member. Course Information: May be repeated. Students may register in more than one section per term. No graduation credit for students in the following: MS in Electrical and Computer Engineering and PhD in Electrical and Computer Engineering. Prerequisite(s): Consent of the instructor.

ECE 598. M.S. Thesis Research. 0-16 hours.
M.S. thesis work under the supervision of a graduate advisor. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Students may register in more than one section per term. Prerequisite(s): Consent of the instructor. For ECE majors only.

ECE 599. Ph.D. Thesis Research. 0-16 hours.
Ph.D. thesis work under supervision of a graduate advisor. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Students may register in more than one section per term. Prerequisite(s): Consent of the instructor. For ECE majors only.